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few places the "floatage" was bound together by a growth of algæ, but mainly adherent without it. In these creeks there was the heaviest breeding of *Anophelas quadrimaculatus* I have ever seen over a large area. The patches of "floatage" were measurable in acres and fractions of an acre rather than in square yards. In Quantico Creek they were at both sides of the channel, but none within 300 feet, say, of the shore. In Chappawampsic Creek they were mainly near the mouth and on the side next to the camp. Here they were within half a mile, maybe less, of the tents in which we found the Anopheles and were most probably their source. Quantico Creek is about a mile wide where this "floatage" was found. Chappawampsic is about 1¾ or 2 miles wide at its mouth. We estimated the average number of larvæ per dip at 8, but one dipper took 52. They were of all sizes, and pupæ were also present. In addition to the breeding in this "floatage" there was breeding in some of the lotus beds, where the leaves of this plant fell into the water and adhered together as they decayed. Where the leaf stood up above the water there was no breeding. The same conditions, breeding in floatage in deep water, had been noted on Broad River, S. C., and other places in our work on Impounded Waters, but none so spectacular as this.

In all of these cases the matting of the "floatage" prevented the breaking of the waves, which passed through it in long smooth swells, and furnished a perfect protection against fish. It must also have provided a good food supply.

The problem of the control of this breeding is a very difficult one.

EFFECT OF ANOPHELES PUNCTIPENNIS ON THE NATURAL CONVEYANCE OF MALARIAL FEVER.

By H. R. CARTER, Assistant Surgeon General, United States Public Health Service.

There is no question that *A. punctipennis* is capable of conveying malarial fever. King first (1915) showed that mosquitoes of this species were readily infectible and that the malaria parasite underwent complete sporogenous development in them. Mitzmain later (1916) produced malarial fever in men by the bites of infected mosquitoes of this species. To what extent they convey malaria *in nature*, however, is not determined.

It has been shown (Public Health Bulletin No. 79) that this mosquito is rarely found in residences—houses occupied by men—in the day time. Where both species are breeding to the same extent *A. quadrimaculatus* is found in such houses in far greater numbers than *A. punctipennis*. If this is because *A. punctipennis* do not enter the residence to feed, it would imply that they are less efficient as vectors of malaria than *A. quadrimaculatus.* It may be, however, that they enter residences at night, feed and leave before morning. Such evidence as we have is against this, but it is not enough to be convincing. It was purposed to determine this point last summer, but owing to the war this study could not be carried out. Indeed, observations to determine the general problem "To what extent is *A. punctipennis* a vector in nature" had been planned from several sides, biological and epidemiological, but were necessarily abandoned when the extra-cantonment work was taken up. The following epidemiological observations, however, bearing on this subject, were made:

A malaria survey was made in August 1917 of Camp Meade, Md., and its environment—about 18 square miles. Eight residences gave a history of malarial fever in 1916 and 1917 at four places. Examinaion of 74 places breeding Anopheles showed 5 of them producing *A. quadrimaculatus* or *A. crucians.* The remaining places were breeding only *A. punctipennis.* Punctipennis were also found in three of the other places with the other species.

Note that malaria was reported in houses near all the places producing *Anopheles quadrimaculatus* or *crucians* except one.[1] Of some 300 houses where the malaria history was taken, the great majority of which were near places producing punctipennis, only one reported malaria. The country was, as seen from the number of houses, very thickly settled, mainly by whites, and in the part most thickly settled the breeding of Anopheles (punctipennis) was as general as I have ever seen. I don't mean as profuse, although it was free and in places profuse.

It is obvious that the diagnosis of malaria based on the statements of patients can not be accepted without reserve, but at four of these houses (all near breeding places of *A. quadrimaculatus* or *A. crucians*) the history of repeated chills and fevers, given by intelligent people, was very clear, and Derivaux states that he found a number of such cases (in 1915) near the other place breeding quadrimaculatus. The statement of those claiming freedom from malaria can, I think, generally be accepted, as it involved freedom from any kind of sickness. The census of the houses was made by the State board of health, but special inquiries, at five of the houses, were made by myself.

In this locality, then, the production of *A. punctipennis* in large number and adjacent to many white people was not associated with malarial fever, while that of *A. quadrimaculatus* and *A. crucians* was.

This may be correlated with our observations at Greenville, S. C., in 1914 and 1915. In June, August, and September a stream running through the heart of this town was absolutely swarming with *A. punctipennis* larvæ and the imagos were abundant in culverts, spring inclosures, etc. Yet Greenville was practically free from malaria. There was some malaria, but it was scarcely a sanitary problem. The same was true of Rock Hill, S. C.: a large production of *A. punctipennis* and only a very moderate amount of malaria. The same appears to be true of the country around Atlanta. Grimm, of the Public Health Service, states that in a large number of blood specimens examined at Spartanburg, S. C., during two and one-half years, he failed to find the malaria parasites except in cases that had recently come from malaria sections. Yet Le Prince reports *A. punctipennis* breeding freely in this section last fall, and I think this was true in 1914 also.

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[1] There was a house near this place, but it probably was not visited or there was no one at home when it was visited.

During the investigation of impounded waters some country neighborhoods were found with a large number of punctipennis and only a moderate amount of malaria, contrasted with communities in which quadrimaculatus was prevalent and malaria decidedly common. For instance, a survey of the Valley of Broad River, S. C., from Dawkins to Blair, was made by Griffitts in 1916. Punctipennis was breeding freely in all of this section, which, however, was not considered as malarious (measured by the standard of this section) except at the Buckhead Settlement. Here it was prevalent, notoriously so, and here *A quadrimaculatus* was breeding freely in some large ponds. More imagoes of this species were taken in the first house examined at Buckhead than in the 12 days' work in the punctipennis district. Several somewhat similar instances could be given from these investigations. Observations consistent with the above have been made at other places.

I have never found malaria prevalent where only punctipennis was breeding, but Brumfield of Virginia has reported quite an outbreak of malaria where this was the only species. There was also a sharp epidemic at Greenville, S. C., in 1912, although whether punctipennis was the only form then present is not known.

The above report of conditions about Camp Meade is made so that other men may be encouraged to record observations of similar (or contrasting) conditions, i. e., the relation of the prevalence of *A. punctipennis* to the presence or absence of malarial fevers. The definite determination of the efficiency of this species as a vector *in nature* compared with *A. quadrimaculatus* and *A. crucians*, is of very great importance to the sanitarian. If it is not a vector of serious sanitary importance—for which there is certainly some evidence—we will avoid undertaking the very large amount of work required for the control of its production. Its breeding habits are quite different from those of *A. quadrimaculatus* (and to a lesser degree from those of *A. crucians*) both in character of place and in season, and special measures are required for the control of this species not needed for the others. Over the whole United States the cost of these and other measures for controlling punctipennis would run into many millions each year, which should not be expended if the malaria averted by them—for punctipennis unquestionably does convey some malaria—causes less loss than would the expense of averting it. To spend a dollar in sanitation and get less than one hundred cents' benefit is not only bad business, but bad sanitation.

To what extent each of the three species of Anopheles most common east of the Rocky Mountains, *A. quadrimaculatus*, *A. crucians*, and *A. punctipennis*, is a factor in the *natural* conveyance of malaria is possibly the most important of our field problems.